MODEL CR20-150

SYSTRON DONNER

INSTRUCTION MANUAL

MODEL CR20-150

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SYSTRON DONNER CORPORATION

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SECTION I - DESCRIPTION

1.1 INTRODUCTION

The Trygon Century Series power supply is a flexible and dependable source of D. C. power, which can be used to meet a variety of needs. These needs may range in scope from inspection and production testing, to laboratory bench testing and systems applications.

The wide range of outputs available makes this unit well suited for use as a basic laboratory power source. The ability to provide power packaged in minimum space with high reliability meets the demands of most systems requirements.

All components used in the construction of the Trygon Century units are of the highest quality available, and have been subjected to 100% incoming inspection.

Each electrolytic filter capacitor is of computer grade, and has been quoted by the manufacturer as having a life expectancy exceeding ten (10) years. Each power transistor has been "derated" and temperature aged to provide high reliability. All rectifiers are hermetically sealed silicon units, and all Zener diodes have been temperature stabilized.

1.2 GENERAL FEATURES

Output, Sensing and Remote Voltage Programming terminals are located on a terminal board mounted on the rear panel of the unit. The power switch, pilot lamp, current and voltage controls and appropriate metering devices are all located on the front panel.

1.2.1 Constant Voltage Mode

A constant voltage is maintained across the output terminals at any pre-set value from zero to rated voltage output, provided that the load does not draw more than either the rated output current or more than the pre-set limiting current value determined by

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1.2.1 Constant Voltage Mode (Cont'd)

the front panel current control settings.

1.2.2 Constant Current Mode

Constant current operation is achieved by maintaining a constant voltage across an internal current sensing resistor. An automatic cross over network changes the mode of operation from Constant Voltage to Constant Current when the current demand reaches that of the pre-set current adjust control. The point at which the operating mode automatically changes is a function of variations in load conditions. The cross over point is adjustable, and can be established anywhere within the current and voltage range of the unit.

1.2.3 Automatic Current Limiting

Short circuit protection is provided by the Automatic Current Limiting circuit which limits the maximum output current under all load conditions. The point at which automatic current limiting occurs is variable, and may be selected anywhere within a range varying from 1% of the rated current output, to the full rated current output of the unit. In the event of a short circuit, the output voltage drops to near zero, and returns to normal only when the short circuit is removed.

1.2.4 Automatic Overvoltage Protection (Optional Feature)

Automatic Overvoltage (OV) protection is available as an option wherein special circuitry automatically tracks the programmed output voltage and prevents it from exceeding this output voltage. The voltage differential that will cause the OV to trip is approximately 5% or 1.5 volts above the programmed voltage. An internal sensitivity control is provided to desensitize the overvoltage protection circuit.

1.2.5 Remote Programming

Remote Programming is provided in the voltage mode of operation. The voltage output may be remotely programmed over its entire range. The scale factor for Remote Voltage Programming is 50 ohms per volt.

1.3 PRECAUTIONARY MEASURES

1.3.1 Wire Size

To assure proper regulation under all load conditions, and to prevent severe distortions of the AC line voltage, it is very important to take into consideration the physical size and current handling capabilities of the input power line. Serious losses in regulation and an increase in ripple may result from under rated or over loaded AC input lines.

1.3.2 Voltage Regulator and Inverter Inputs

Do not use voltage regulators or inverters as a primary power source. The outputs of these devices are usually not sinusoidal in nature, and if used as the AC source for the power supply, will cause serious loss of regulation of the power supply output. Capacitive input filtering used for semiconductor power supplies requires charging to the peak of the rectified AC wave which non-sinusoidal AC sources cannot provide.

1.3.3 Variable Transformer Input

If a variable transformer is to be used to test the power supply for low and high AC line operation, it must be able to supply at least twice the VA requirements of the power supply and load.

1.3.4 Systems Considerations

In systems applications it is recommended that each power supply input power line be run separately to the AC distribution box, in order to minimize cross coupling and interaction between equipment. Do not run sensitive signal leads such as the remote sensing leads in the same cable as the AC input. It is strongly recommended that the AC input cables should not be run in close proximity to the output load cable leads, if minimum ripple is desired.

1.3.5 Terminal Post Resistance

All terminals and shorting links serving Outputs, Sensing and Programming must be securely tightened before use. Serious

1.3.5 Terminal Post Resistance (Cont'd)

loss of regulation and an increase in ripple can result due to a voltage drop caused by loose terminals and shorting links.

1.4 SPECIFICATIONS

With the exception of special customer requirements listed below, all electrical and physical specifications for the Trygon Century Series power supplies appear on the following Trygon Specification Sheet.

TRANSISTORIZED POWER SUPPLIES

CENTURY SERIES

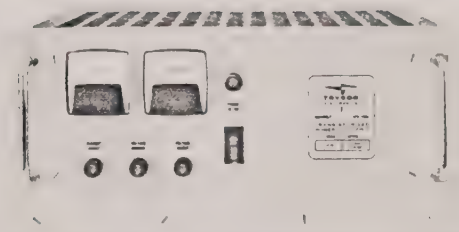
CONSTANT VOLTAGE/CONSTANT CURRENT

C Series

OUTPUT:	0-15 VDC/0-36 VDC /0-60 VDC/0-160 VDC
REGULATION, LINE:	0.01% or 3 mv
LOAD:	0.01% or 3 mv
RIPPLE:	Less than 1 mv RMS
INPUT:	105-125 VAC, 55-65 cps

FEATURES

- AUTOMATIC SHORT CIRCUIT PROTECTION
- REMOTE VOLTAGE PROGRAMMING
- REMOTE SENSING
- SERIES OR PARALLEL OPERATION



ELECTRICAL SPECIFICATIONS

CONSTANT VOLTAGE MODE WITH ADJUSTABLE CURRENT LIMITING

Input: 105-125 VAC, 55-65 cps. (200-240 VAC, 50, or 400 cps available).
Output: Floating; isolated from ground, 300 VDC max.
Regulation, Line: 0.01% or 3 mv,* for 105-125 VAC line change at any output within specifications.
Regulation, Load: 0.01% or 3 mv,* no load to full load at any output within specifications.
Ripple: Less than 1 mv RMS.
Stability: 0.05% or 18 mv* for 8 hours after warm-up. Measured at constant line voltage, load and ambient temperature.
Temperature Coefficient: (0.03% + 400 μv)/°C.
Temperature Range: −20°C to + 50°C.
Recovery Time: 100 microseconds to recover within specified band, for 100% step change in rated load.
Short Circuit Protection: Automatic Adjustable Current Limiting (ACL) variable from 1% to 100% of rated current.
AC Power Input Protection: Circuit Breaker.
Remote Programming: All units remotely programmable over output voltage range. Scale factor approximately 50 ohms/volt except C160-8C and C160-16C which are 100 ohms/volt.
Remote Sensing: Maintains rated regulation directly at the load. Maximum line drop 0.5 volts per leg.
Voltage Adjustment Range: Continuously adjustable vernier controls.

CONSTANT CURRENT MODE WITH ADJUSTABLE VOLTAGE LIMITING

Current Range: 1% to rated current output.
Voltage Compliance: 0 to rated output voltage.
Regulation, Line: 0.15% or 75 ma* for 105-125 VAC line change at any output within specifications.
Regulation, Load: 0.15% or 75 ma* output current change for the maximum change in load resistance within the rated voltage compliance range.
Ripple: 0.5% or 10 ma.*
Stability: 0.2% or 20 ma* for 8 hours after warm-up. Measured at constant line voltage, load and ambient temperature.
Temperature Coefficient: 0.1% I_{rated}/°C.

*Whichever is greater

TABLE 1

	OUTPUT				DIMENSIONS			
Model	**Volts**	**Amps**	***Impedance DC-1KC**	**Recovery Band (mv)**	**W**	**H**	**D**	**Weight (lbs.)**
C15-80	0-15	0-80	0.001	50	19	8¾	16	120
C36-50	0-36	0-50	0.001	25	19	8¾	16	120
C60-25	0-60	0-25	0.001	50	19	8¾	16	120
C160-8C	0-160	0-8	0.002	100	19	8¾	16	100
C160-16C	0-160	0-16	0.001	150	19	10½	16	120

*Nominal

GENERAL AND PHYSICAL SPECIFICATIONS

Operational Modes: Constant Voltage with adjustable current limiting; Constant Current with adjustable voltage limiting; Automatic Crossover.

Controls:
Voltage: Coarse and Fine voltage adjusts; front panel.
Current: Coarse current adjust; front panel.
Input Power: Front panel switch and indicator.

Metering:
Voltage: Front panel voltmeter.
Current: Front panel ammeter.

Terminals:
Rear Panel: Pos. Output (+V) — Neg. Output (−V) — Ground (G) — Pos. Sensing (+S) — Neg. Sensing (−S) — Remote Voltage Programming (REM) — AC input —(AC).

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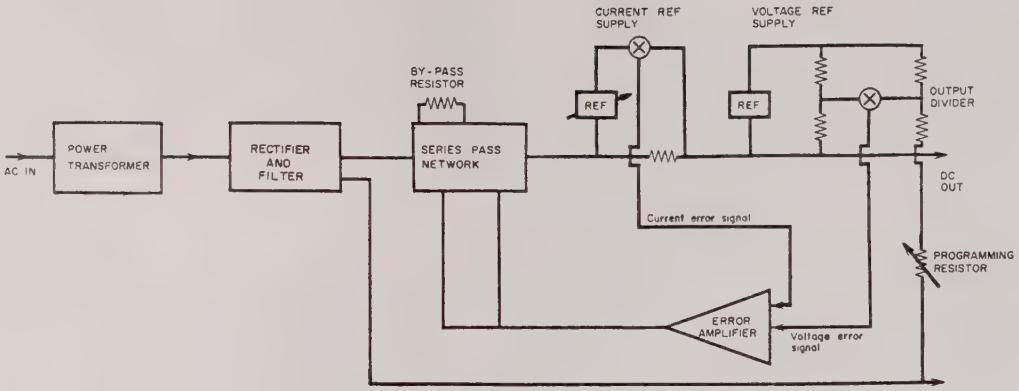


Block Diagram — Century Series

DESCRIPTION

• The Trygon CENTURY SERIES are dependable, 19" wide rack type power supplies designed for systems as well as laboratory applications. These units will operate reliably to their maximum temperature without any derating, addition of heat sinking or external forced air cooling.

• CONSTANT VOLTAGE and CONSTANT CURRENT operation is provided with automatic crossover from one mode into the other. In the voltage mode, adjustable current limiting is provided while the current mode provides adjustable voltage limiting. All units in this series have provisions for remote programming of voltage.

• MAXIMUM RELIABILITY is achieved through the use of proven design techniques, component selection, and rugged construction. High quality components are used throughout and power transistors are generously derated and temperature aged, zener diodes are temperature stabilized, electrolytic capacitors are computer grade with rated life in excess of 10 years, transformers meet or exceed the requirements of MIL-T-27A, and all Trygon power supplies are manufactured in accordance with the Quality Assurance requirements of MIL-Q-9858. The Century Series units carry the Trygon 5 year warranty.

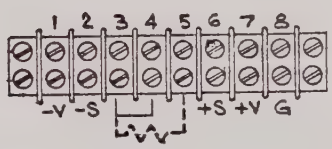
• AUTOMATIC TRACKING OVERVOLTAGE PROTECTION (OV)* is a patented automatic fail-safe overvoltage protection circuit pioneered by Trygon. The OV circuit protects the load against receiving a voltage in excess of the programmed output voltage of the supply. The protection point automatically tracks the programmed output voltage.

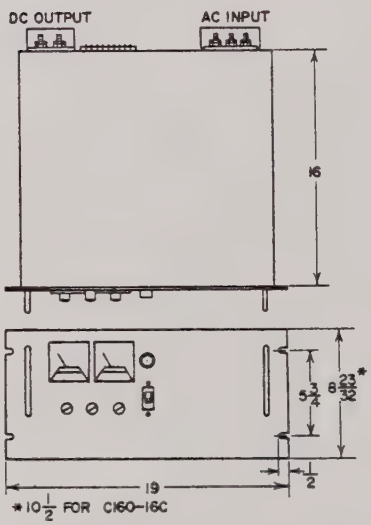
• SERIES OR PARALLEL OPERATION to increase voltage or current can easily be accomplished by connecting two or more supplies of this series together.

• SPECIAL MODIFICATIONS: The standard Century Series units are available in four voltage ranges. Their outstanding versatility, reliability, and operating convenience make them ideally suited for a large majority of applications in standard form.

• TRYGON ELECTRONICS, INC., has available a number of standard options and modifications to extend even further the range of performance or application of each power supply. In addition, the Trygon Application Engineering department is available for consultation on specific applications.

*Optional





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SECTION II - INSTALLATION AND OPERATION

2.1 MECHANICAL INSTALLATION

2.1.1 General

When the Trygon Century series power supply is used in a rack or bench type configuration, no special mechanical installation is required.

2.2 ELECTRICAL CONNECTIONS

2.2.1 AC Input

Three heavy duty lugs and studs mounted on a block on the rear panel marked AC, provide AC input power connections for the unit. The input line must be connected across the two outer terminals, as the center terminal is used for a ground connection.

The power handling ability of the AC power lines feeding AC power to these connectors must be considered, as serious losses in regulation and substantial increases in ripple can occur as a result of insufficient power handling capacity of these lines. All AC power line connections must be securely tightened, and any movable electric contact surface (such as the wiper arm of a variable transformer) should be kept clear of impedance producing oxide coatings.

Care should be exercised in selecting the proper wire size for the AC input lines. Table 2-1 will serve as a guide in making this selection. The figures listed in the wire length columns indicate the wire size required for each of the Century Series power supplies, depending upon the length of the run of the AC input leads. All wire lengths refer to single lead length, and all wire sizes conform to AWG standards.

2.2.1 AC Input (Cont'd)

TABLE 2-1 - AC INPUT POWER WIRE SIZE				
Model	1' to 10'	10' to 20'	20' to 50'	50' to 100'
C15-50	10	8	6	4
C36-30	10	8	6	4
C60-15	10	8	6	4
C160-8	10	8	6	4
C15-80	8	6	4	2
C36-50	8	6	4	2
C60-25	8	6	4	2
C160-16	8	6	4	2

2.2.2 Barrier Strips

An eight terminal barrier strip mounted on the rear panel provides Output, Sensing, Remote Programming, and ground connections. Barrier strip terminal connections marked -V (1) and +V (7) have been provided as convenience terminals only, and are not to be used for the purpose of connecting the output of the unit to the load. Their function is to be used in conjunction with the shorting links provided for the purpose of maintaining local sensing.

2.2.3 DC Output

DC output connections are provided in the form of heavy duty lugs and studs mounted on a block on the rear panel, and binding post connectors mounted on the front panel. These connections are marked DC, - and +, and are the only connectors to be used for connecting the DC output of the power supply to the load.

2.2.4 Shorting Links

The unit is shipped with shorting links in place across terminals 1 and 2, 3 and 4, and 6 and 7, of the barrier strip. In this configuration, local programming and sensing is available at the barrier strip terminals. Table 2-2 lists the various shorting link connections and their functions.

TABLE 2-2 - SHORTING LINK APPLICATION

Terminals	Condition	Function
1 and 2 6 and 7	Shorted Shorted	Local sensing and regulation at rear panel barrier strip terminals
1 and 2 6 and 7	Not Connected Not Connected	Remote sensing and regulation at load
3 and 4 4 and 5	Shorted Open	Voltage programmed locally, output dependent upon voltage adjust pots
3 and 4 4 and 5	Ext. PGM res. Shorted	Voltage programmed remotely, output dependent upon size of PGM resistor

NOTES: 1) If remote voltage programming terminals (3 and 4) are left open, the output voltage will become unregulated.

2) See paragraph 1.2.5 for approximate PGM resistor scale factors.

2.3 CONTROLS

2.3.1 Front Panel

TABLE 2-3 - FRONT PANEL CONTROLS

Symbol	Name	Function
CB1	AC POWER	Circuit breaker, controls input power
R33	VOLTAGE ADJUST	Potentiometer, adjusts voltage output
R34	VOLTAGE VERNIER	Potentiometer, adjusts voltage output
R64	CURRENT LIMIT ADJUST	Potentiometer, adjusts current

2.3.2 Internal

All internal control settings have been factory pre-set, and require no additional adjusting. However, if it should become necessary to adjust any of the internal controls due to circuit changes caused by component ageing or replacement, refer to the calibration section of this instruction manual.

2.4 OPERATION

2.4.1 Control Settings

Set all front panel controls fully CW so that unit will operate in the Voltage rather than Current Limiting mode.

2.4.2 Shorting Links

If Local Sensing rather than Remote Sensing operation is desired, ascertain that shorting links are in place across the appropriate terminals.

2.4.3 Grounding

Either side of the Output may be grounded, or the Output may be used in a floating condition.

2.4.4 Power On

Connect the unit to a suitable source of 115 VAC, 60 cycle power. Set circuit breaker CB1 to AC-ON, and observe that pilot lamp DS1 glows.

2.4.5 Warm-Up

No warm-up time is necessary to place the unit into operation. However, a 30 minute warm-up period is recommended to reach rated stability.

2.4.6 Series Operation

To operate two or more power supplies in a series configuration, connect the output of each power supply in series. When operating in this mode, it is necessary to adjust the output of each unit independently. The output voltage is equal to the sum of the voltage settings of each power supply.

2.4.7 Parallel Operation

A) With rated resistive load connected across the output of power supply A as shown in Figure 2-1A, set VOLTAGE ADJUST control to desired output voltage, and set CURRENT ADJUST control for maximum rated output current.

B) Connect power supply B as shown in Figure 2-1B. With no load across the output, set VOLTAGE ADJUST control for an output voltage 2 volts higher than the output voltage of power supply A. Place a short across the output terminals, and set the CURRENT ADJUST control for 1/2 the total load current requirement.

C) Remove all former output loads and connect the outputs of power supplies A and B in parallel with each other, and in parallel with the load, as shown in Figure 2-2.

D) If parallel operation of these two power supplies is desired for a systems application, it is important that both units

2.4.7 Parallel Operation (Cont'd)

be turned on simultaneously. It is therefore recommended that both power supplies be connected to a single large circuit breaker. Maximum output current will be twice that of either of the two power supplies, while minimum output current will be that of power supply B, or half the total load current.

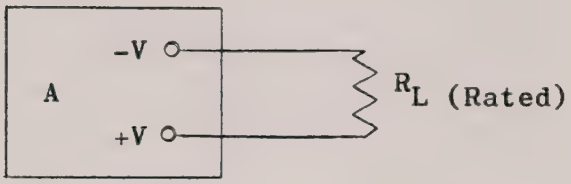

FIGURE 2-1A

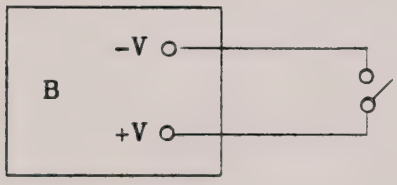

FIGURE 2-1B

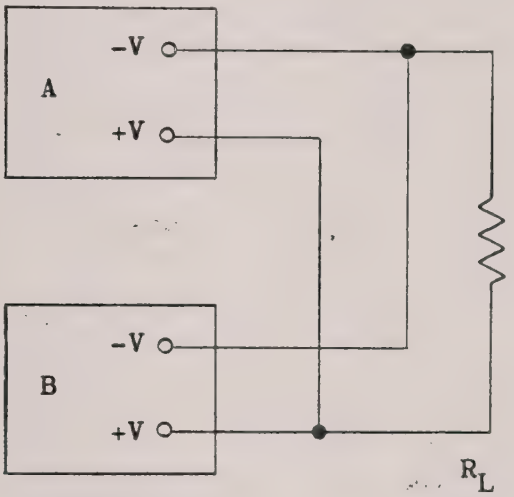

FIGURE 2-2

NOTE: If parallel operation of Trygon power supplies utilizing overvoltage (OV) protection is desired, consult the factory for special instructions.

SECTION III - THEORY OF OPERATION

3.1 GENERAL

The purpose of the Trygon Century Series power supply is to transform and rectify the AC input into a well regulated, stable and adjustable DC output. In performing these functions, the circuitry of the unit may be broken down into five basic sections, which shall be referred to in the following order:

1) Primary Input
2) Reference Supply
3) Pre-Regulator
4) Series Regulator
5) Comparator and Error Amplifier

3.2 CIRCUIT ANALYSIS

The circuitry of this power supply has been outlined in simplified form in the Block Diagram located at the rear of this section. As each basic circuit is described, it will be advantageous to refer to the Block Diagram and the Schematic Diagram located at the rear of this section.

3.2.1 Primary Input

Input power is obtained through transformers T1, T2 and T3. When circuit breaker CB1 is set to AC ON, pilot lamp DS1 illuminates and AC power is applied to T1, T2 and T3, and cooling fans B1 and B2. Regulated DC output voltage is immediately available from the power supply.

3.2.2 Reference Supply

The purpose of the reference supply is to provide a stable fixed voltage for the Comparator and Error Sensing amplifier. Q23 acts as a comparator sensing any difference in the voltage

3.2.2 Reference Supply (Cont'd)

developed across zener diode CR26 and R45, and the voltage divider composed of R47 and R48 across the output of the reference supply. The error signal is amplified by Q23 and sent on via Q22 and Q21 to vary the sensitivity of Q20 so as to keep the reference voltage across C19 constant.

3.2.3 Pre-Regulator

The purpose of the Pre-Regulator is to maintain the unregulated input voltage on input filter capacitors C2, C3 and C4, at a suitable value, to lower the power dissipation across the Series Pass section.

The method used to accomplish this is to fire a pair of silicon controlled rectifiers (SCR's) CR1 and CR2 at controlled points along the input sine wave to increase or decrease the potential to which the input capacitor may charge.

The SCR's are "fired" (i.e. allowed to pass current(by the application of a positive pulse to points G1 and G2 on the schematic, from pulse transformers T4 and T5. The SCR's remain fired until points K1 and K2 reach 0 volts potential and turn them off.

In order for pulse transformers T4 and T5 to develop the gating signals for the SCR's, Q25 and Q27 must both be made to conduct. Inhibit gate Q25 is controlled by Inhibit Amplifier Q24, which in turn is programmed by the differentiating network composed of R29 and C13. The input signal to this differentiating network is derived from Inhibit Rectifiers CR17 and CR18. The positive portions of the differentiated signal do not allow conduction of Q24, but the negative portions do. Conduction of Q24 in turn causes conduction of Q25. Therefore, as Q24 conducts only during the time the negative portion of the differentiated wave is applied to its base, the Inhibit circuit prevents any pulse from being developed across pulse transformers T4 and T5 at any time other than during the latter half of each half cycle of the input wave.

3.2.3 Pre-Regulator (Cont'd)

Transistors Q26 and Q27 form a differential amplifier stage. R54 and R55 establish a fixed reference for the base of Q26, which in turn fixes the emitter potential of Q26 and Q27. The base signal for Q27 is derived from the voltage divide network consisting of R26, R27 and R16 in the input circuit. As the input signal swings from zero volts to peak negative and then back to zero, a point is reached at which Q27 becomes forward biased. When Q27 conducts, Pulse Transformers T4 and T5 can pass gating pulses through to the SCR's. As long as the input and output voltages remain constant, the SCR's will continue to fire at the same time during the latter half of each cycle. However, if there should be a change in either input or output levels, the SCR's will fire at a correspondingly earlier or later time, so as to increase or decrease the potential to which the input capacitor may charge. Zener diode CR35 limits the voltage across the primaries of T4 and T5 to 6 volts.

3.2.4 Series Regulator

The pre-regulated DC voltage from the SCR is directed through Series Pass transistors Q1 through Q15, and Q35 and Q36. The conduction of these transistors is controlled by control circuitry which causes them to act as variable resistors. Their overall resistance varies in accordance with the need of the power supply to increase or decrease its output voltage and current.

The Series Pass transistors are controlled by Q19, Q18 and Q17 emitter followers which are driver stages to amplify the control signals from the error amplifier. Transistor Q40 is an I_{CO} generator for the Series Pass transistors.

3.2.5 Comparator and Error Amplifier

The voltage sensing and comparison is accomplished by Q33 and Q34 arranged as a differential amplifier. A sample of the programmed voltage on the base of Q34 is compared to the stable reference voltage on the base of Q33. An unbalance caused by a change

3.2.5 Comparator and Error Amplifier (Cont'd)

in voltage at either the negative sensing terminal (-S) or across the voltage adjustment circuitry R33, R34, R78 and R80 will appear as a voltage change in the collector of Q33.

This error voltage is amplified by Q32, Q30 and Q31, and is used to adjust the Series Pass to correct the unbalance in the comparator via the Q19 driver. In the current mode of operation, the voltage developed across resistors R83, R22 and R23 is fed to the base of Q28, thereby forcing that transistor into conduction. When Q28 conducts, CR32 becomes forward biased, thereby effectively feeding the error signal on through Q32, Q30 and Q31, and drivers Q19, Q18 and Q17, to the Series Pass circuit, where the original error signal causes the necessary increase or decrease in output amplitude.

3.3 OPTIONAL FEATURES

3.3.1 Overvoltage Protection

A sample of the output voltage is compared to a stable reference voltage derived from Zener diode CR56. If the output voltage exceeds the reference level, Q42 will conduct. The level at which Q42 conducts is variable, and may be set by adjusting R88. Conduction of Q42 in turn causes Q41 to conduct which then "fires" SCR CR42. When CR42 fires, an effective short circuit is placed across the output terminals. This condition will occur if there is a failure in the Series Pass and the output voltage rises or if there is a line transient or voltage feedback in the output line.

A malfunction in the Reference supply will cause Q43 to conduct which will also cause conduction of Q41 and CR42, thereby providing overvoltage protecting action.

SECTION IV - MAINTENANCE

- WARNING -

High Voltages Are Present
Use Caution

4.1 GENERAL

This power supply is a precision instrument. It is strongly recommended that only experienced trouble shooting personnel perform troubleshooting operations or attempt to repair the unit. If the power supply appears to be malfunctioning at all, the following procedure is recommended for isolating possible defects.

4.2 LOADS AND INTERCONNECTIONS

1) Disconnect all loads and interconnections.
2) Connect a resistive load across the output terminals, and operate the unit to determine whether the fault lies within the unit or externally. Observe that shorting links are in place across terminals 1 and 2. **3 and 4, and 6 and 7, and that all connections are tightly made.**
3) Set input voltage to 115 VAC nominal, and output voltage to rated output.

4.3 TROUBLESHOOTING

1) Set VOLTAGE ADJUST control R33 and VOLTAGE VERNIER control R34 fully CW. Use a 20,000 ohms per volt voltmeter or oscilloscope to check the voltages

across the various circuit components listed in the Troubleshooting tables of this section. Any reading which is grossly incorrect indicates that the stage being tested or the one immediately preceding it, is defective. The Block Diagram, Schematic Diagram and appropriate sections of the Theory of Operation will prove helpful in any troubleshooting work. Proper polarity to be observed when testing can be easily obtained from the Schematic Diagram.

2) If voltage checks show no noticeable deviations from the prescribed values, disconnect AC power and proceed with point to point resistance checks across pots, switches, diodes, resistors, transistors in that order.

3) When the trouble is of an intermittent nature such as poor regulation, ripple etc., the use of an oscilloscope to determine dynamic changes will be necessary. The section on Theory of Operation should be consulted to determine circuit performance with varying output conditions.

4.3.1 Reference Supply

TABLE 4-1 REFERENCE SUPPLY VOLTAGES

Measured Across Component	DC Voltage Reading ±10%
C16	25.0
*CR23 - CR24	1.4
R43	9.0
CR26	9.3
R47	9.3
C19	15.0

*Voltage measured across both components

4.3.2 Comparator

TABLE 4-2 COMPARATOR VOLTAGES	
Measured Across Component	DC Voltage Readings ±10%
R76	5.0
R69	6.7
R56	9.0
R54	9.0
R65	6.7

4.3.3 Series Pass

TABLE 4-3 SERIES PASS VOLTAGES	
Measured Across Component	DC Voltage Reading ±10%
C2, C3 or C4	46.0
C6	65.0
C7	-15.0
C8	15.0

NOTE: The base to emitter voltages of all transistors in the Series Regulator should be negative for conduction.

SECTION V - CALIBRATION

5.1 GENERAL

The following adjustments should be made when necessary to assure optimum operating characteristics and maximum efficiency of the Trygon power supply

5.2 TEST EQUIPMENT REQUIRED (or equivalent)

(A) Oscilloscope, Tektronix Type 561
(B) Differential Amplifier Plug In, Tektronix Type 63
(C) Time Base Plug In, Tektronix Type 67
(D) Differential VTVM, Fluke Model 825A
(E) AC VTVM, Hewlett Packard Model 400D
(F) VOM, Simpson Model 260
(G) Variable Auto transformer, Superior Electric Co., Type 1156D (45 ampere rating).

5.2.1 Shorting Link Application

For test purposes, shorting links should be connected across terminals 1 and 2, 3 and 4, and 6 and 7, to provide local sensing and voltage programming. To reduce pick up, shielded wire must be used for all connections between test equipment and the power supply being tested. To prevent ground loops, it is important that only one ground connection be made, as shown in Figure 5-1 and Figure 5-2. Tighten all terminal connections as securely as possible, and set all front panel controls fully CW.

5.3 CALIBRATION PROCEDURE

5.3.1 Voltage Adjust Controls

A) Maximum Voltage Control

Vary voltage controls and observe that output voltage varies as indicated on unit and test voltmeters. Maximum voltage

5.3.1 Voltage Adjust Controls (Cont'd)

should be approximately 0.5 to 1.0 volts above the rated output of the unit. If it is not possible to attain this voltage, Reference Adjust control R78 should be readjusted.

> NOTE: If partial rotation of the VOLTAGE ADJUST controls produces no apparent change in indicated output voltage, further rotation of these controls should not be attempted. Rotation of these controls fully CCW with little or no output voltage regulation can result in damage to the controls, the load, or both. Set the AC POWER switch to OFF, and proceed with the troubleshooting outlined in Section 4 of this instruction manual.

B) Minimum Voltage Control

Set voltage controls fully CCW and observe that the voltage indicated on the unit and test voltmeters drops slightly below the zero setting of the meters. The output voltage should be approximately negative 200 MV. If it is not possible to attain this voltage, readjust Minimum Voltage adjust control R80. Reset voltage controls fully CW.

5.3.2 Current Adjust Controls

A) Maximum Current

Connect a test ammeter having a vull scale current indicating capacity of 150% that of the rated current output across the output terminals of the power supply. (Set all front panel controls fully CCW.) Apply power to the unit under test and slowly rotate CURRENT ADJUST control R64 fully CW. Observe that the maximum current obtainable is approximately 120% that of the rated current output. If it is not possible to achieve 120% that of the rated current output, adjust Maximum Current control R111 until that value is attained. Set AC Power Switch to OFF.

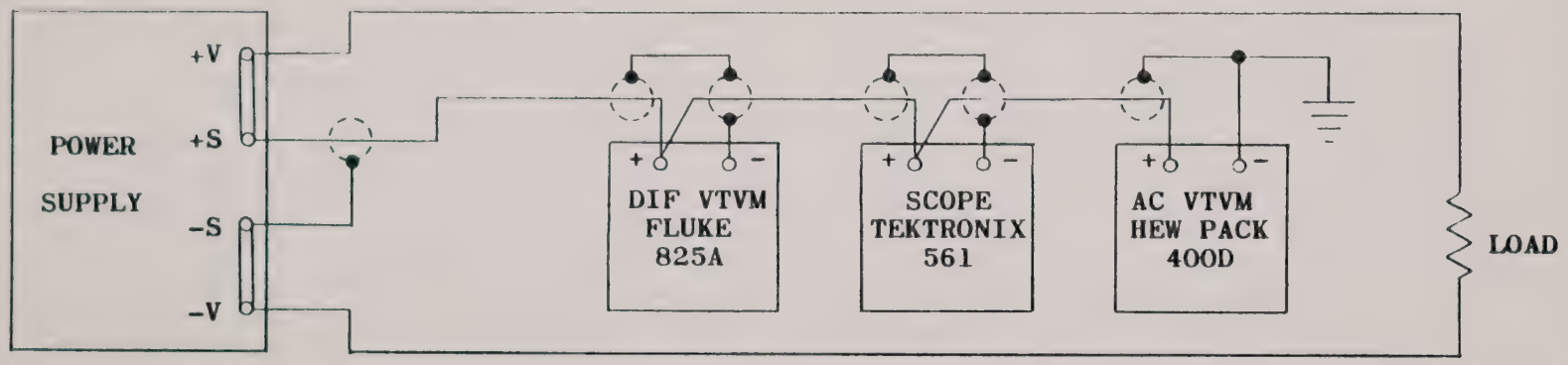

FIGURE 5-1
CONSTANT VOLTAGE OPERATION

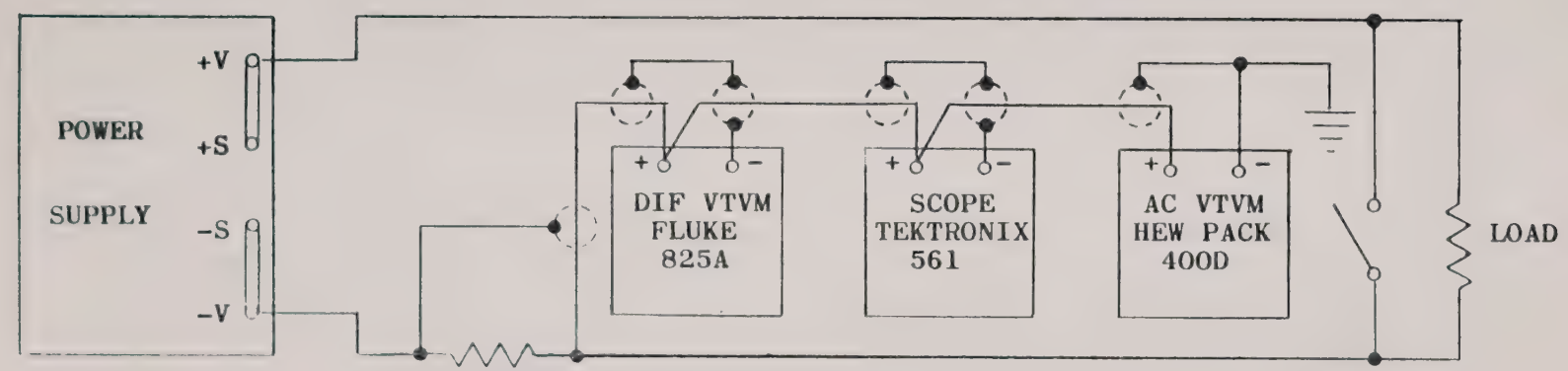

FIGURE 5-2
CONSTANT CURRENT OPERATION

TRYGON
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5.3.2 Current Adjust Controls (Cont'd)

Connect a suitable load resistance across the output terminal connections. The load resistance must be able to dissipate the rated power of the unit (P = IE) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Set AC Power Switch to ON. Note the voltage indicated on the Differential VTVM. Disconnect the resistive load from the output and observe the voltage indicated on the Differential VTVM. The maximum change in output voltage should not exceed by more than 0.01% or 3mv (whichever is greater) that of the output voltage indicated with the load resistance applied across the output terminals.

If it is not possible to maintain the load regulation as stated in the preceding paragraph, re-adjust Maximum Current control R111 slightly and re-check the load regulation. Further minor adjustment of Maximum Current control R111 may be necessary to achieve both proper load regulation and 120% of rated current output.

B) Minimum Current

Connect test ammeter, having a full scale current indicating capacity of 1% of the rated current across the output terminals in place of a load resistor. Set all front panel controls fully CCW and apply power to the unit under test. Slowly rotate Voltage Adjust control in a CW direction until the current meter indicates a current flow of 1% of the rated current. If this value cannot be obtained, adjust Minimum Current control R62 for the desired current indication of 1% of the rated current. Set POWER ON switch S1 to OFF.

5.3.3 Constant Voltage Operation

A) Load Regulation

With the equipment connected as shown in Figure 5-1, connect a suitable load resistance across the Output terminal connections. The load resistance selected must be able to

5.3.3 Constant Voltage Operation (Cont'd)

dissipate the rated power of the unit (P = EI) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Note the voltage indicated on the Differential VTVM. Disconnect the resistive load from the output. The maximum change in output DC voltage indicated on the Differential VTVM should not exceed by more than 0.01% or 3mv (whichever is greater) that of the output voltage indicated with the load resistance applied across the output terminals.

B) Line Regulation

Place the resistive load across the output and note the voltage indicated on the Differential VTVM. Vary the input line voltage between 105 and 125 VAC. The maximum change in output voltage should not exceed by more than 0.01% or 3mv (whichever is greater) that of the output voltage measured at either extreme of the AC input.

C) Ripple Voltage

In order to reduce pickup, shielded test leads should be used in making ripple measurements. With the resistive load connected across the output terminals, measure the AC ripple with the AC VTVM. Vary the input line voltage between 105 and 125 VAC. The maximum ripple amplitude should not exceed 1.0mv RMS.

5.3.4 Constant Current Operation

A) Load Regulation

With the equipment turned off, disconnect the resistive load from the output terminals. Connect a small current sensing resistor in series with the resistive load and then connect the load back across the output terminals. Selection of the proper value for the current sensing resistor may be easily made using the formula $R_S = \frac{1}{I_R}$ where R_S = Value of Current Sensing Resistor and I_R = Rated Load Current. Connect the equipment as shown in Figure 5-2, and apply power to the power supply.

5.3.4 Constant Current Operation (Cont'd)

Vary the VOLTAGE ADJUST controls and resistive output load as necessary, to achieve rated current and voltage output. Decrease the load resistance until current meter reading exceeds full scale indication. Rotate CURRENT ADJUST control CCW to return the current meter reading to full scale. Observe that the output voltage has decreased from its previous full scale reading, and that increasing the VOLTAGE ADJUST controls has no effect upon the output voltage or current. This indicates that the unit is now operating in the Constant Current Mode.

Measure the voltage across the small sensing resistor. Compute and note the current flow through this resistor. Change the output load from the resistive load previously used, to a short. Again measure the voltage across the small sensing resistor. The change in current should not exceed by more than 0.1% or 50ma (whichever is greater) the rated current previously noted with a full resistive load across the output.

B) Line Regulation

Replace the resistive load across the output and measure the voltage drop across the small sensing resistor. Compute and note the current flow ($I = \frac{E}{R}$) through this resistor.

Vary the input line voltage between 105 and 125 VAC. Note the maximum change in voltage across the sensing resistor and compute the maximum current flow. The maximum change in current should not exceed by more than 0.1% or 50ma (whichever is greater) the rated current previously noted at either extreme of the AC input.

C) Ripple Current

With the AC input line voltage adjusted to the nominal value of 115 volts and the resistive load connected across the output, measure the amplitude of the AC ripple as seen across the sensing resistor with the AC VTVM. Compute and note the current flow. Vary the AC input line voltage between 105 and 125 VAC. Measure the maximum voltage drop and compute the maximum current flow. The maximum ripple current must not exceed more than 1% of the rated current with nominal input line voltage.

5.3.5 Remote Voltage Programming

In order to obtain very accurate remote programming over the entire voltage range, a scale factor of 50 ohms per volt is maintained. Since the accuracy of this scale factor is dependent upon the accuracy of the test instruments employed in making this adjustment, it is recommended that test instruments of at least 0.1% accuracy be utilized.

Prior to making this adjustment, be certain that shorting links are in place between terminals 1 and 2 and 6 and 7 and that they are fastened securely. Set current adjust controls fully CW.

A) Scale Factor Adjust

1. Remove shorting link between terminals 3 and 4, and connect it in place between terminals 4 and 5.
2. Connect a laboratory standard test resistor of 1000Ω between terminals 3 and 5.
3. Connect a differential voltmeter directly across the 1000Ω resistor.
4. Adjust R78 (on main component board) until exactly 20 volts is measured across the 1000Ω resistor. This measurement must be precisely made, as the accuracy of the programming scale factor is dependent upon it.

B) Zero Offset Adjust

To compensate for resistance in power cabling to the power supply, a slight negative offset voltage has been provided which must be compensated for.

1. Remove the 1000Ω standard test resistor previously connected between terminals 3 and 5, and connect the remote programming wiring in its place. Place a short circuit across the end of this wiring.
2. Connect a differential voltmeter across Output Sensing terminals 2 and 6.
3. Adjust R80 (on main component board) until the differential voltmeter indicates a voltage as close to zero as possible.

5.3.5 Remote Voltage Programming (Cont'd)

Other factors which should be considered when making remote programming measurements are:

1. Ambient temperature changes.
2. Resistor types. Only low temperature coefficient resistors (20 PPM) should be utilized.
3. Contact resistance of external switches, relays and connectors in the programming resistance path.

5.3.6 Overvoltage (OV) Sensitivity

The sensitivity of the Overvoltage Protection circuit is determined by the setting of Overvoltage Sensitivity control R88. This control is factory pre-set to cause a short circuit to be applied across the output of the unit if the output voltage attempts to rise more than 5% or 1.5 volts above the programmed voltage.

Although an internal control, R88 is not "locked" (soldered) in place as are the other internal controls, but may be varied to suit the individual needs of the user. This control may be varied from outside the unit by inserting a screwdriver through one of the ventilation holes in the top of the power supply case.

To determine the proper point at which the overvoltage control R88 should be set to automatically shut the unit off, connect the output of a second power supply having a higher output voltage capability, in parallel with the unit under test. Set the output of the second unit 1 1/2 volts higher than that of the first unit. Adjust R88 until the unit under test automatically shuts itself off.

LIST OF ELECTRICAL PARTS -

Designation	Component	MFR	Part Number	Spares	TRYGON STOCK #
B1,2	Fan Muffin	ROT	VENTURI	2	890020
C1	Cap. 75MF, 50V	C.D.	NLW75-50	1	810100
C2	Cap. 100MF, 50V	SPRA	39D107G050EJ4	1	810131
C3,9,10,11	Cap. 30MF, 50V	SPRA	40D306F050DH4	4	810050
C4	Cap. .1MF, 200V	SPRA	148P10402	1	800180
C5,6	Cap. 500MF, 75V	SPRA	39D507G075HL4	2	810223
C7	Cap. 250MF, 6V	SPRA	40D257F006DH4	1	810170
C8,19,20,21,24	Cap. 10MF, 50V	MALL	TYPE TTXE	5	810010
C12,13,14,15,16, 17	Cap. 115000MF, 25V	TRY	820475	6	820475
C18	Cap. 1MF, 250V	I.E.	CM10000-2	1	800304
C22	Cap. 450MF, 50V	SPRA	39D457G050FP4	1	810212
C23	Cap. .1MF, 250V	I.E.	CM1000-2	1	800185
C25,26,27	Cap. .05MF, 200V	ERIE	825030ZK1503M	3	800168
CR1,2,3,4,5,6,7, 14,15,16,17,18, 19,29,30,31,32, 33,34,35,36,37, 38,39,40,41,42, 43,44,45,46,47, 48,49,50,51,52, 53,54,55,56,57, 58,59,60,61,62, 63,64,65,67,106	Diode	G.I.	1N4384	52	720384
CR8,10,13,27	Diode Zener	TRAN	1N751A	4	720181
CR9	Diode Zener	MOTO	Z0132	1	720263
CR11	Diode Zener	HOFF	1N1360A	1	720241
CR12,28	Diode Zener	UNIT	UZ715	2	720150
CR20,21,22	Scr	G.E.	C60A	3	720053
CR23,24,25	Diode	TRY	720124	3	720124
CR26	Diode	G.E.	1N3262R	1	725077
CR66	Diode Zener	TRAN	SV515	1	720110
CR68,70	Diode	TRY	TR4148	2	720440

LIST OF ELECTRICAL PARTS -

Designation	Component	MFR	Part Number	Spares	TRYGON STOCK =
CR71	Diode Zener	UNIT	UZ806	1	720151
CB1	Ckt. Breaker	HEIN	3263S	1	760116
R1	Rmf. 681Ω, .5W, 1%	IRC	TYPE CECTO	1	620220
R2	Rmf. 100Ω, .5W, 1%	IRC	TYPE CECTO	1	620030
R3,43	Rmf. 511Ω, .5W, 1%	IRC	TYPE CECTO	2	620180
R4	Rmf. 249Ω, .5W, 1%	IRC	TYPE CECTO	1	620080
R5,66,72	Rcomp. 1KΩ, .5W, 10%	A-B	RC20GF102K	3	610180
R6	Rmf. 9.95KΩ, .5W, 1%	IRC	TYPE CECTO	1	620600
R7	Rcomp. 390Ω, .5W, 10%	A-B	RC20GF391K	1	610130
R8,41	Rcomp. 100Ω, .5W, 10%	A-B	RC20GF101K	2	610070
R9,42	Rmf. 199.95KΩ, .5W, .5%	IRC	TYPE CECTO	2	620900
R10,36	Rmf. 1KΩ, .5W, 1%	IRC	TYPE CECTO	2	620300
R11,14,16,23,24 38,40,46,93	Rmf. 4.99KΩ, .5W, 1%	IRC	TYPE CECTO	9	620580
R12,15	Rmf. 6.81KΩ, .5W, 1%	IRC	TYPE CECTO	2	620596
R13,39	Pot. 150Ω, 1.5W	TRY	600071	2	600071
R17,18	Rmf. 1.5KΩ, .5W, 1%	IRC	TYPE CECTO	2	620360
R19,22	Rcomp. 220KΩ, .5W, 10%	A-B	RC20GF221K	2	610500
R20	Rcomp. 470Ω, .5W,10%	A-B	RC20GF471K	1	610140
R21	Rmf. 604Ω, .5W, 1%	IRC	TYPE CECTO	1	620210
R25	Rcomp. 100KΩ, .5W, 10%	A-B	RC20GF104K	1	610350
R26	Rmf. 402Ω, .5W, 1%	IRC	TYPE CECTO	1	620140
R27,48	Pot. 500Ω, 1.5W	TRY	600146	2	600146
R28	Rmf. 1.99KΩ, .5W, 1%	IRC	TYPE CECTO	1	620430
R29,31	Rmf. 3.01KΩ, .5W, 1%	IRC	TYPE CECTO	2	620480
R30	Rltc. 200Ω, 3W, 3%	SAGE	1300S200-3	1	630270
R32	Rcomp. 47KΩ, .5W, 10%	A-B	RC20GF470K	1	610340
R33	Rww. 50Ω, 10W, 5%	W-L	10XM50	1	640300
R34	Resistor 300Ω, 5W	CLARO	VC5E	1	640420
R35	Rltc. 250Ω, 3W, 3%	SAGE	1300S250-3	1	630280
R37	Rcomp. 1.2KΩ, .5W, 10%	A-B	RC20GF122K	1	610190

LIST OF ELECTRICAL PARTS -

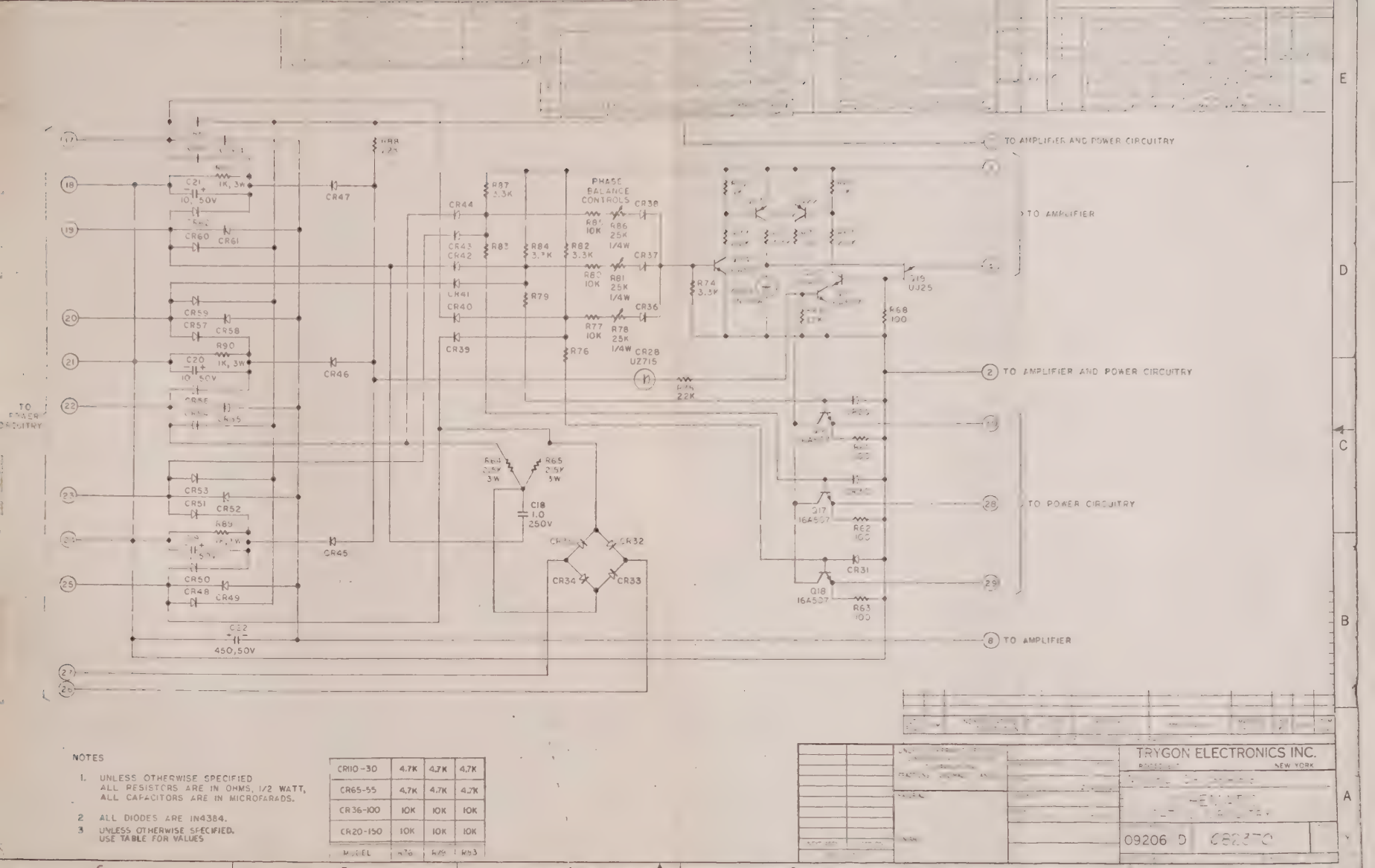
Designation	Component	MFR	Part Number	Spares	TRYGON STOCK #
R44,45	Rcomp. 150Ω, .5W, 10%	A-B	RC20GF151K	2	610080
R47	Rmf. 150Ω, .5W, 1%	IRC	TYPE CECTO	1	620050
R49,	Pot. 100Ω, 2W	TRY	600059	2	600059
R50	Pot. 2.5KΩ, 2W	TRY	600230	1	600230
R51	Shunt 150 Amp.	TRY	106680	1	106680
R52,56,57	Rww. .2Ω, 10W	W-L	TYPE 10X	3	640030
R53,54,55	Rww. 4Ω, 150W	MILW	TYPE 18-64RX	3	650223
R58	Rww. 150Ω, 3W, 3%	SAGE	1300S150-3	1	630260
R59	Rww. 500Ω, 25W	IRC	TYPE-2D	1	650660
R61,62,63,68,70	Rcomp. 100Ω, .5W, 10%	A-B	RC20GF101K	5	610070
R64,65	Rltc. 2.5KΩ, 3W, 3%	SAGE	1300S2.5K-3	2	630450
R67,73	Rcomp. 2.2KΩ, .5W, 10%	A-B	RC20GF222K	2	610210
R69,75,88	Rcomp. 2.2KΩ, .5W, 10%	A-B	RC20GF222K	3	610310
R71,74,82,84,87	Rcomp. 3.3KΩ, .5W, 10%	A-B	RC20GF332K	5	610230
R76,77,79,80,83 85	Rcomp. 10KΩ, .5W, 10%	A-B	RC20GF103K	6	610290
R78,81,86	Pot. 25KΩ, .25W, 10%	CTS	UPE200R	3	600364
R89,90,91	Rltc. 1KΩ, 3W, 3%	SAGE	1300S1K-3	3	630390
R92	Pot. 50Ω, 1.5W	CTS	TYPE 100	1	600021
Q1,2,3,4,5,6,10 11,16,17,18,20 21,24	Transistor	G.E.	16A507	14	700180
Q7,8,22,23	Transistor	TRY	TR1132	4	700000
Q9	Transistor	TRY	TR2195	1	700110
Q12,13,14,15	Transistor	TRY	TR1490	4	700080
Q19	Unijunction	TRY	UJ25	1	720145
K1	Relay	A-C	TS1544C8.4MA	1	760275
L1	Choke	TRY	505408	1	505408
DS1,2,3	Pilot Light	I-D	1040A87	3	770020
DS4	Light Indicator	I-D	2190A87	1	770023
M1	Meter 150A	AMMON	TYPE AP2	1	750106
M2	Meter 20V	AMMON	TYPE AP2	1	752037
T1	Transformer	TRY	505407	1	505407

LIST OF ELECTRICAL PARTS -

Designation	Component	MFR	Part Number	Spares	TRYGON STOCK =
T2,3,4	Transformer	TRY	B1674C	3	501010
R60	Pot. 50Ω, 2W	TRY	600030	1	600030

LIST OF ELECTRICAL PARTS -

Designation	Component	MFR	Part Number	Spares	TRYGON STOCK #
C100	Cap. 25MF, 50V	G.E.	GE62F30S	1	810045
CR100,101,107	Diode	TRY	TR4148	3	720440
CR102	Diode	TRAN	1N751A	1	720181
CR103	Thyristor	MOTO	MAC3-2	1	725140
CR104	Diode	MOTO	MR1220	1	725056
CR105	Scr	G.E.	C80F	1	725008
R100	Rmf. 3.01KΩ, .5W, 1%	IRC	TYPE CECTO	1	620480
R101	Rww. 680Ω, 2W	IRC	TYPE BWH	1	640490
R102	Rcomp. 220Ω, .5W, 10%	A-B	RC20GF221K	1	610100
R103	Rcomp. 3.3KΩ, .5W, 10%	A-B	RC20GF332K	1	610230
R104	Pot. 10KΩ	CTS	TYPE 100	1	600410
R105	Rcomp. 1KΩ, .5W, 10%	A-B	RC20GF102K	1	610180
R106	Rltc. 800Ω, 3W, 3%	SAGE	1300S800-3	1	630380
R107	Rcomp. 470Ω, .5W, 10%	A-B	RC20GF471K	1	610140
R108	Rww. 250Ω, 10W	W-L	10XM250	1	640400
R109	Rcomp. 10Ω, .5W, 10%	A-B	RC20GF100K	1	610000
Q101	Transistor	MOTO	2N4238	1	700047
Q102	Transistor	TRY	TR2905	1	700115
L2	Choke	TRY	501380	1	501380



NOTES

1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE IN OHMS, 1/2 WATT, ALL CAPACITORS ARE IN MICROFARADS.
2. ALL DIODES ARE IN4384.
3. UNLESS OTHERWISE SPECIFIED, USE TABLE FOR VALUES

CR110-130	4.7K	4.7K	4.7K
CR65-55	4.7K	4.7K	4.7K
CR36-100	10K	10K	10K
CR20-150	10K	10K	10K
MODEL	R76	R66	R63

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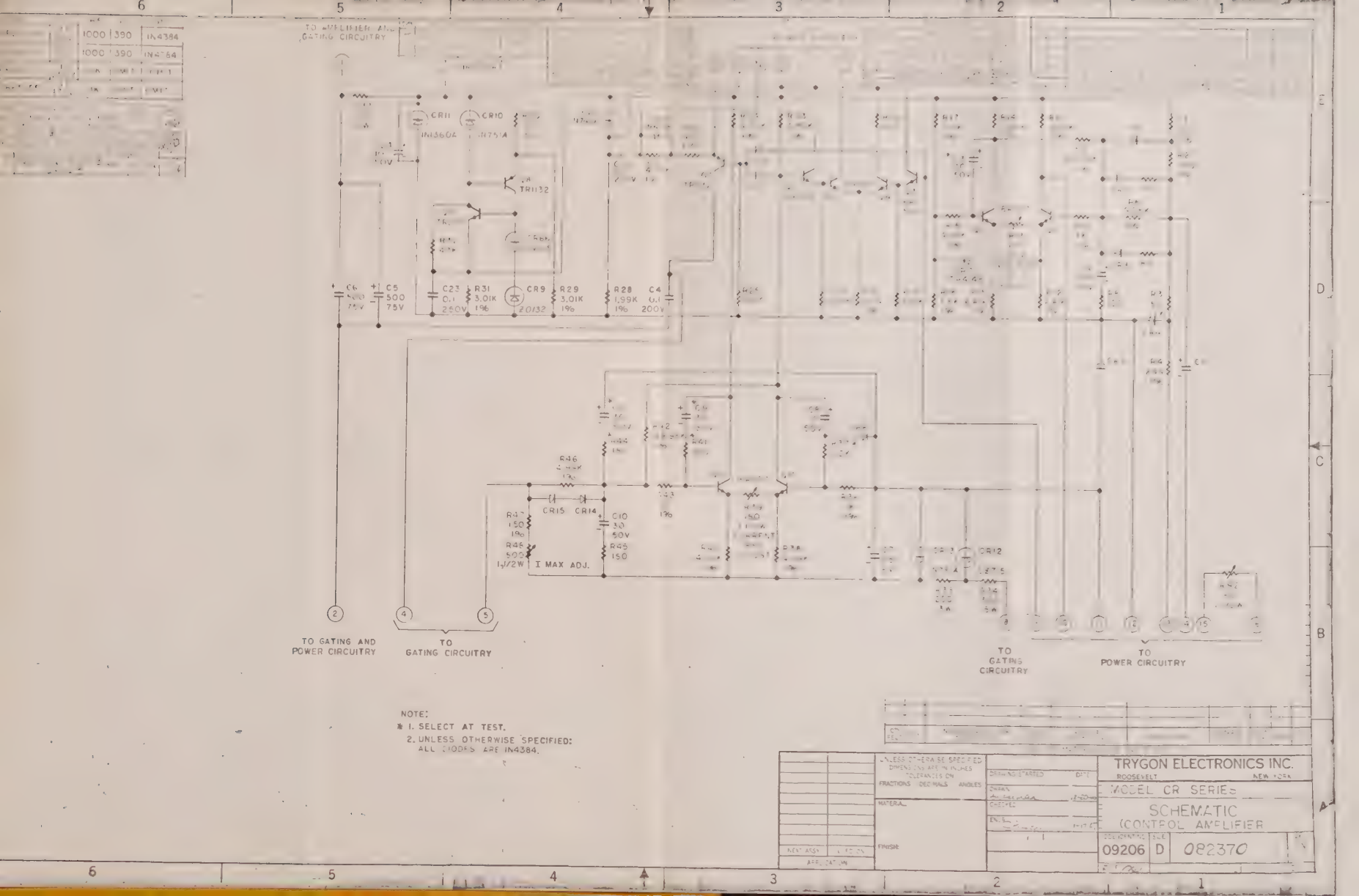
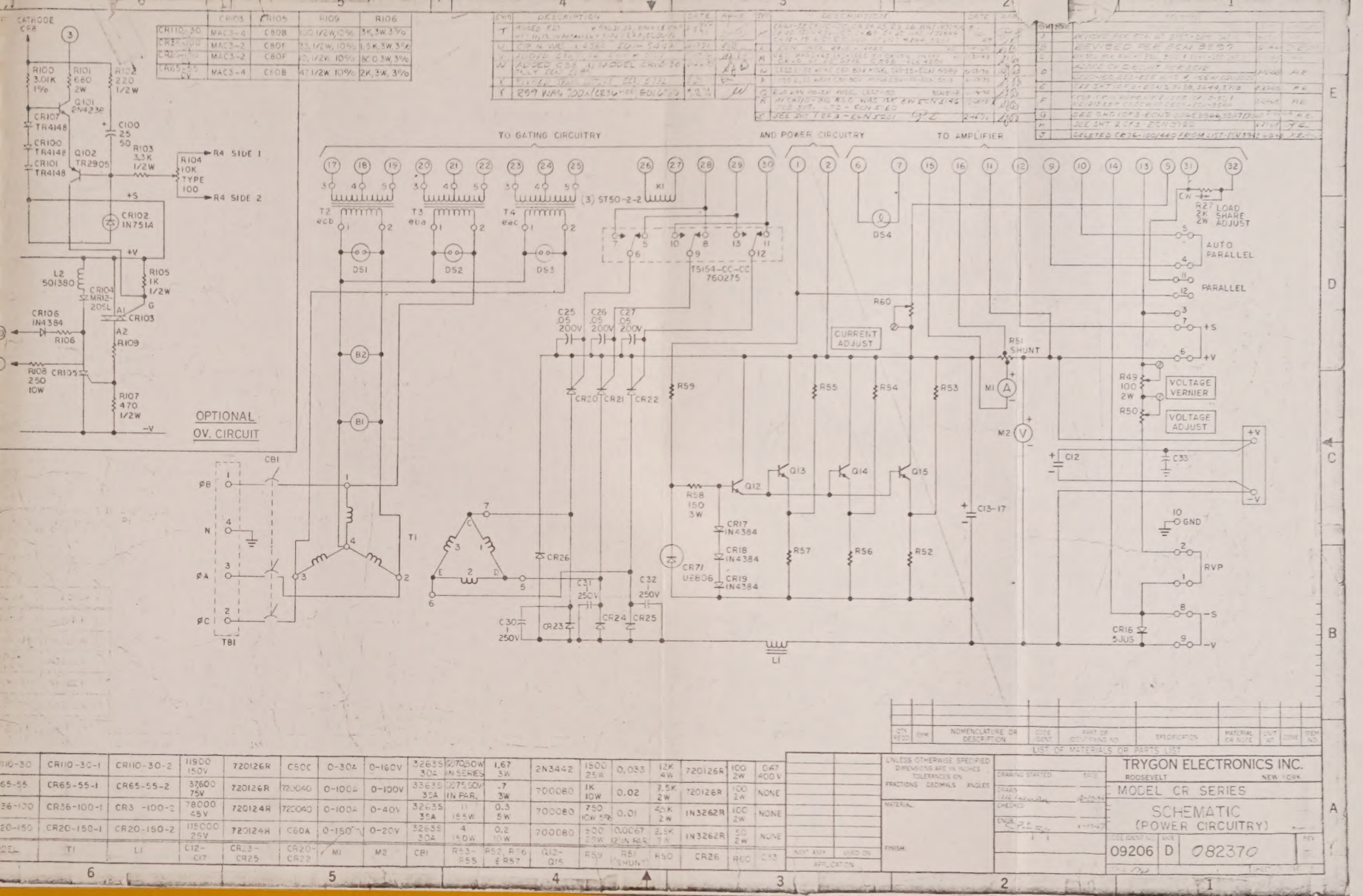


NOTE:
* 1. SELECT AT TEST.
2. UNLESS OTHERWISE SPECIFIED: ALL DIODES ARE IN4384.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS DECIMALS ANGLES
MATERIAL
FINISH
DRAWN STARTED DATE
CHECKED
ENG.

TRYGON ELECTRONICS INC.
ROOSEVELT NEW YORK
MODEL CR SERIES
SCHEMATIC
(CONTROL AMPLIFIER
DRAWING NO. 09206 SIZE D
082370



110-30	CR110-30-1	CR110-30-2	11500 150V	720126R	C50C	0-30A	0-160V	32635 30A	2070.80W IN SERIES	1.67 5W	2N3442	1500 25W	0.033	12K 4W	720126R	100 2W	CR47 400V
65-55	CR65-55-1	CR65-55-2	37600 75V	720126R	720040	0-100A	0-100V	33635 30A	2075.00W IN PAR.	.7 3W	700080	1K 10W	0.02	7.5K 2W	720126R	100 2W	NONE
36-100	CR36-100-1	CR3 -100-2	78000 45V	720124R	720040	0-100A	0-40V	32635 35A	11 155W	0.3 5W	700080	750 10W 5%	0.01	4.5K 2W	IN3262R	100 2W	NONE
20-150	CR20-150-1	CR20-150-2	115000 25V	720124R	C60A	0-150A	0-20V	32635 30A	4 150W	0.2 10W	700080	500 20W	0.0067 12 IN PAR	2.5K 7W	IN3262R	50 2W	NONE
CR2-	T1	L1	C12-C17	CR23-CR25	CR20-CR22	M1	M2	CB1	R53-R55	R52, R56 ER57	Q12-Q15	R59	R51 (SHUNT)	R50	CR26	R60	C33

QTY REQD	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	PART OR IDENTIFYING NO	SPECIFICATION	MATERIAL OR NOTE	UNIT WT	ZONE	ITEM NO

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES

MATERIAL

FINISH

NEXT ASSY USED ON

APPLICATION

DRAWING STARTED DATE

CHARG DATE

CHECKED

ENGR

TRYGON ELECTRONICS INC.
ROOSEVELT NEW YORK

MODEL CR SERIES

SCHEMATIC
(POWER CIRCUITRY)

DOCUMENT NO. 09206 | SIZE D | DWG NO. 082370 | REV

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MP MASTER
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